APPENDIX C

REPLACEMENT SPECIFCATION – CLEAN COPY

BACKGROUND OF THE INVENTION

[0002] The claimed subject matter relates to a metered feeding pump for definitively measuring the output and flow of a liquid media, measuring container volume, and calibrating liquid medium flow measurement instruments and devices.

[0003] Conventional volume tube measuring devices can only measure the volume of the medium passing through the volume tube, not the volume of the medium passing through the entire device. An example of a known feeding pump measuring device is disclosed in Chinese Patent 90200439.5. In the disclosed pump measuring device, only relatively small amounts of medium can be measured, and only in fixed volumes. The disclosed device is not suited for more accurate measurements or for measuring relatively large volumetric flows.

BRIEF SUMMARY OF THE INVENTION

[0004] In order to overcome the shortcomings of conventional volume tube measuring devices, the claimed subject matter combines the functions of a traditional volume tube device and a medium measurement feeding pump. In certain embodiments, a volume tube measurement device measures piston displacement and calculates a piston displacement quantity based on the displacement per piston, with a measurement unit that is a product of the minimum resolution unit of the grating ruler and the cross section area of volume tube measurement volume.

[0005] Certain exemplary embodiments of the claimed subject matter include a continuous feeding pump device of volume tube, including volume tube and its dragging mechanism; a measurement volume zone, unilateral liquid inlet valves, and unilateral liquid outlet valves are set in the mentioned volume tube. In certain exemplary embodiments, the mentioned volume tube has two unilateral liquid inlet valves and two unilateral liquid outlet valves, respectively set at two ends of the inner walls of the mentioned volume tube. A piston is also set in the mentioned volume tube, and the piston is used to connect the mentioned dragging mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 is a structure diagram of an exemplary volume tube continuous feeding pump device.

[0007] FIG. 2 is a structure diagram of an exemplary volume tube continuous feeding pump device with a linear motor.

[0008] FIG. 3 is a timing sequence diagram of lead screw rotation speed and valve lifts of an exemplary continuous feeding pump device.

DETAILED DESCRIPTION OF THE INVENTION

[0009] Combined with the attached drawings, the preferred embodiments of this invention are described in detail as follows:

[0010] A continuous feeding pump device of volume tube includes volume tube 1 having a metering volume section (11) defined therein, a dragging mechanism (2), two unilateral inlet valves (8) and two unilateral outlet valves (7) in two ends of inner wall thereof respectively, and a piston (9), wherein the piston (9) is connected to the dragging mechanism (2).

[0011] In certain embodiments, a grating ruler 4 is set on a moving route of a dragging rod of the mentioned piston (9).

[0012] The mentioned dragging mechanism 2 can also include a servo motor (22), a belt gear (21), a lead screw (23) and a lead screw nut (25), which is connected in turn which are mechanically connected such that the servo motor (22) turns the belt gear (21) which rotates the lead screw (23), which move the lead screw nut (25).

[0013] In exemplary embodiments using a servo motor device, casing pipe (6) is connected with the lead screw (23) and with the mentioned piston (9), and is independent of the lead screw (23). In other exemplary embodiments, the dragging mechanism (2) is a linear motor.

[0014] There are two kinds of concrete methods. In a first method, a ball screw turns the rotation movement of the motor into the rectilinear movement of the piston. Passing each respective inlet and outlet unilateral valve, the measurement volume at two sides of the piston is quantitatively outputted and measured one time in a moving period of the piston. In another exemplary method, a linear motor drives the piston conducting the rectilinear movement, and passing each respective inlet and outlet unilateral valve, the measurement volume at two sides of the piston is quantitatively outputted and measured one time in a moving period of the piston.

[0015] In the exemplary embodiments disclosed, not only can they conduct the quantitative output and measurement for all media passing through the feeding pump device of volume tube, but they can also conduct the self-adaptive control for the medium flow of the customer pipeline system through the control measurement system of the feeding pump device of volume tube, making them a good match with the medium flow of the customer pipeline system. The functions of the active and passive feeding pump devices of volume tube are integrated, the range of the quantitative output and measurement of the medium flow is greatly widened, the measurement devices of the liquid medium flow can be detected in situ, and the functions of the traditional volume tube devices and the medium measurement feeding pump are combined and developed. The corrosion due to connection between the lead screw and the medium to be detected is avoided in that the structure of protecting the lead screw through its casing pipe connected with the piston is used, which is convenient to lubricating and cooling the lead

screw. The dragging mechanism is relatively simple as compared with that of the traditional volume tube devices. The medium flow is also larger than that of the traditional measurement feeding pump devices.

[0016] In some embodiments, like what is shown in FIG. 1 for the structure of feeding pump device of volume tube, servo motor 22 is rotated through belt gear 21 driving lead screw 23, lead screw 23 drags piston 9 conducting the reciprocating motion in volume tube measurement volume 11 by lead screw nut 25 and casing pipe 6 of lead screw. The detected medium from liquid inlet pipe 12 passes liquid inlet unilateral valve 8 into volume tube measurement volume 11, the detected medium passes liquid outlet unilateral valve 7 and falls from volume tube measurement volume 11 into liquid outlet pipe 10, and then the output quantity of the medium can be calculated after precisely measuring the piston position by using grating ruler 4. In this exemplary embodiment, the piston in the volume tube is driven by a ball screw dragged by the motor, and the rotation motion of the motor is turned into reciprocating rectilinear motion using the ball screw.

[0017] A limit micro-switch can be set at the end to ensure the precise reciprocating measurement at each time. Each measurement result is imputed to the computer to conduct the precise statistic and calculation, so as to ensure the measuring accuracy of flow and volume.

[0018] In the other embodiments, like what is shown in FIG. 2 for the structure of the measurement feeding pump device of volume tube, linear motor 2 drives piston 9 conducting the reciprocating motion in volume tube measurement volume 11. The detected medium falls into volume tube measurement volume 11 from liquid inlet pipe 12 and liquid inlet unilateral valve 8, bleeds off volume tube measurement volume 11 through liquid outlet unilateral valve 7, and falls into liquid outlet pipe 10. The medium output quantity is then calculated after conducting the precise measurement for the piston position using grating ruler 4.

[0019] Volume can be measured in both piston directions. For example, when the piston moves towards volume A, the liquid in volume A passes through the unilateral liquid outlet valve and quantitatively bleeds off the liquid to the cylinder outside. At the same time, volume B passes through the unilateral liquid inlet valve and quantitatively feeds the liquid from the cylinder outside. When the piston moves towards volume B, the liquid in volume B passes through the unilateral liquid outlet valve and quantitatively bleeds off the liquid to the cylinder outside. At the same time, volume A passes through the unilateral liquid inlet valve and quantitatively feeds the liquid from the cylinder outside. In this way, volume of the output liquid is measured in both piston directions using the reciprocating motion of the piston.

[0020] Fig. 3 illustrates an exemplary embodiment of switch time sequence of ingress and egress of the unilateral valve of the feeding pump device of volume tube. In the exemplary embodiment shown, when the piston moves towards volume B and reaches the dead point, unilateral liquid inlet valve of side B is turned off after an interval of t_x, and simultaneously unilateral liquid inlet valve of side A is turned off. After an interval

of t_y, unilateral liquid inlet valve of side B is turned on, and simultaneously unilateral liquid inlet valve of side A is turned on. After an interval of t_z, the piston moves towards volume A through counter revolution of the lead screw. When the piston reaches the dead point, unilateral liquid inlet valve of side B is turned off after an interval of t_z, and simultaneously unilateral liquid inlet valve of side A is turned off. After an interval of t_y, unilateral liquid inlet valve of side B is turned on, and simultaneously unilateral liquid inlet valve of side A is turned on. The piston and the inlet and outlet liquid unilateral valve conduct such reciprocating cycle motion. The time interval from the piston stop to the next movement is t seconds, and $t = t_x + t_y + t_z$. The time sequence relation among the lead screw, the piston and the unilateral liquid inlet and outlet valves are shown in FIG. 3.